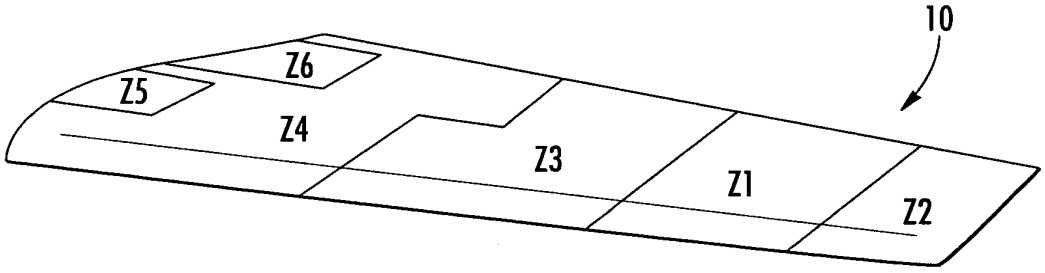


FIG. 1

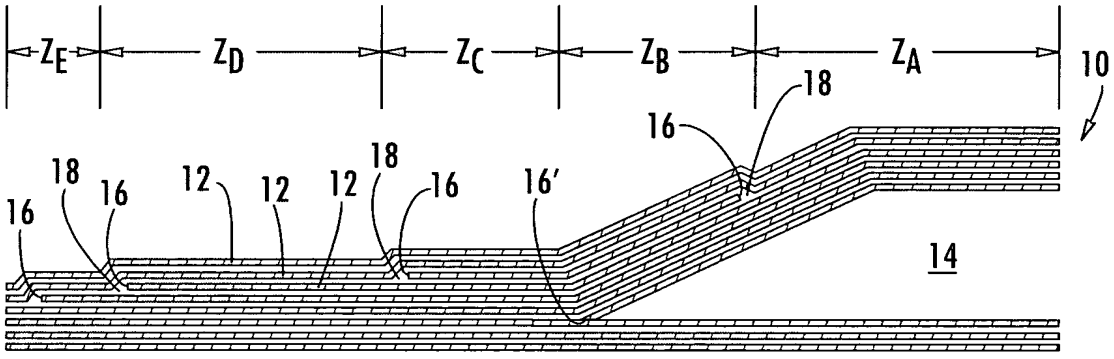


FIG. 2

Zone	0	45	-45	90
Z1	12	8	8	4
Z2	12	8	8	8
Z3	14	10	10	4
Z4	14	12	12	6
Z5	18	14	14	6
Z6	18	14	14	6

FIG. 3

Seq	MZ
1	45
2	90
3	-45
4	0
5	45
6	0
7	-45
8	0
9	45
10	90
11	-45
12	90
13	45
14	90
15	0
16	-45
17	0
18	45
19	0
20	-45
21	0
22	45
23	0
24	-45
25	45
26	-45
27	0
28	0
29	-45
30	45
31	-45
32	0
33	45
34	0
35	-45
36	0
37	45
38	0
39	-45
40	0
41	90
42	45

43	90
44	-45
45	90
46	45
47	0
48	-45
49	0
50	45
51	0
52	-45
53	90
54	45

FIG. 4

Seq	Z1	Z2	Z3	Z4	Z5	Z6
1	45	45	45	45	45	45
2	90	90	90	90	90	90
3	-45	-45	-45	-45	-45	-45
4	0	0	0	0	0	0
5	45	45	45	45	45	45
6	0	0	0	0	0	0
7	-45	-45	-45	-45	-45	-45
8	0	0	0	0	0	0
9	45	45	45	45	45	45
10	90	90	90	90	90	90
11	-45	-45	-45	-45	-45	-45
12	----	90	----	90	90	90
13	----	----	45	45	45	45
14	----	90	----	----	----	----
15	----	----	0	0	0	0
16	----	----	-45	-45	-45	-45
17	----	----	----	----	0	0
18	45	45	45	45	45	45
19	0	0	0	0	0	0
20	----	----	----	-45	-45	-45
21	0	0	0	0	0	0
22	----	----	----	45	45	45
23	----	----	----	----	0	0
24	-45	-45	-45	-45	-45	-45
25	----	----	----	----	45	45
26	----	----	----	----	-45	-45
27	0	0	0	0	0	0
28	0	0	0	0	0	0
29	----	----	----	----	-45	-45
30	----	----	----	----	45	45
31	-45	-45	-45	-45	-45	-45
32	----	----	----	----	0	0
33	----	----	----	45	45	45
34	0	0	0	0	0	0
35	----	----	----	-45	-45	-45
36	0	0	0	0	0	0
37	45	45	45	45	45	45
38	----	----	----	----	0	0

FIG. 5

38	----	----	----	----	0	0
39	----	----	-45	-45	-45	-45
40	----	----	0	0	0	0
41	----	90	----	----	----	----
42	----	----	45	45	45	45
43	----	90	----	90	90	90
44	-45	-45	-45	-45	-45	-45
45	90	90	90	90	90	90
46	45	45	45	45	45	45
47	0	0	0	0	0	0
48	-45	-45	-45	-45	-45	-45
49	0	0	0	0	0	0
50	45	45	45	45	45	45
51	0	0	0	0	0	0
52	-45	-45	-45	-45	-45	-45
53	90	90	90	90	90	90
54	45	45	45	45	45	45

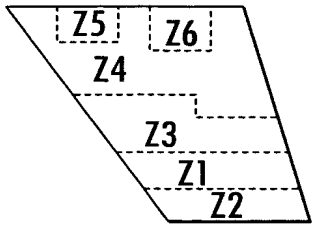


FIG. 6a

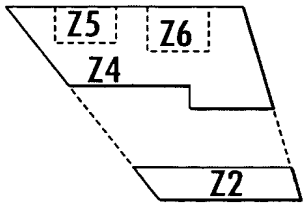


FIG. 6b

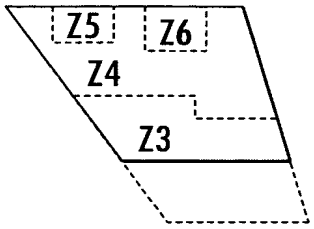


FIG. 6c

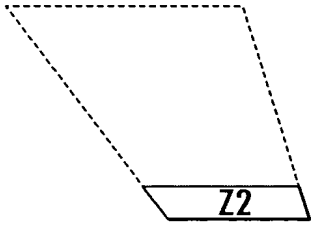


FIG. 6d

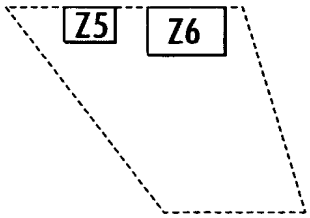


FIG. 6e

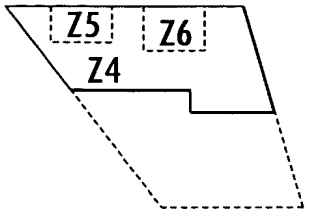


FIG. 6f

	XM1	XM2	XM3	XM4	XM5	XM6	XM7	XM8	XM9	XM10
XS1	1	0	0	0	0	MB(1,6)	MB(1,7)	MB(1,8)	MB(1,9)	MB(1,10)
XS2	MB(2,1)	0	1	0	0	0	MB(2,7)	MB(2,8)	MB(2,9)	MB(2,10)
XS3	MB(3,1)	MB(3,2)	0	0	1	0	0	MB(3,8)	MB(3,9)	MB(3,10)
XS4	MB(4,1)	MB(4,2)	MB(4,3)	0	0	1	0	0	MB(4,9)	MB(4,10)
XS5	MB(5,1)	MB(5,2)	MB(5,3)	MB(5,4)	0	0	0	1	0	MB(5,10)
XS6	MB(6,1)	MB(6,2)	MB(6,3)	MB(6,4)	MB(6,5)	0	0	0	0	1

BI(1)	1
BI(2)	3
BI(3)	5
BI(4)	6
BI(5)	8
BI(6)	10

COL1	COL2	COL3	COL4	COL5	COL6	COL7	COL8	COL9	COL10
1	0	1	0	1	1	0	1	0	1

FIG. 7

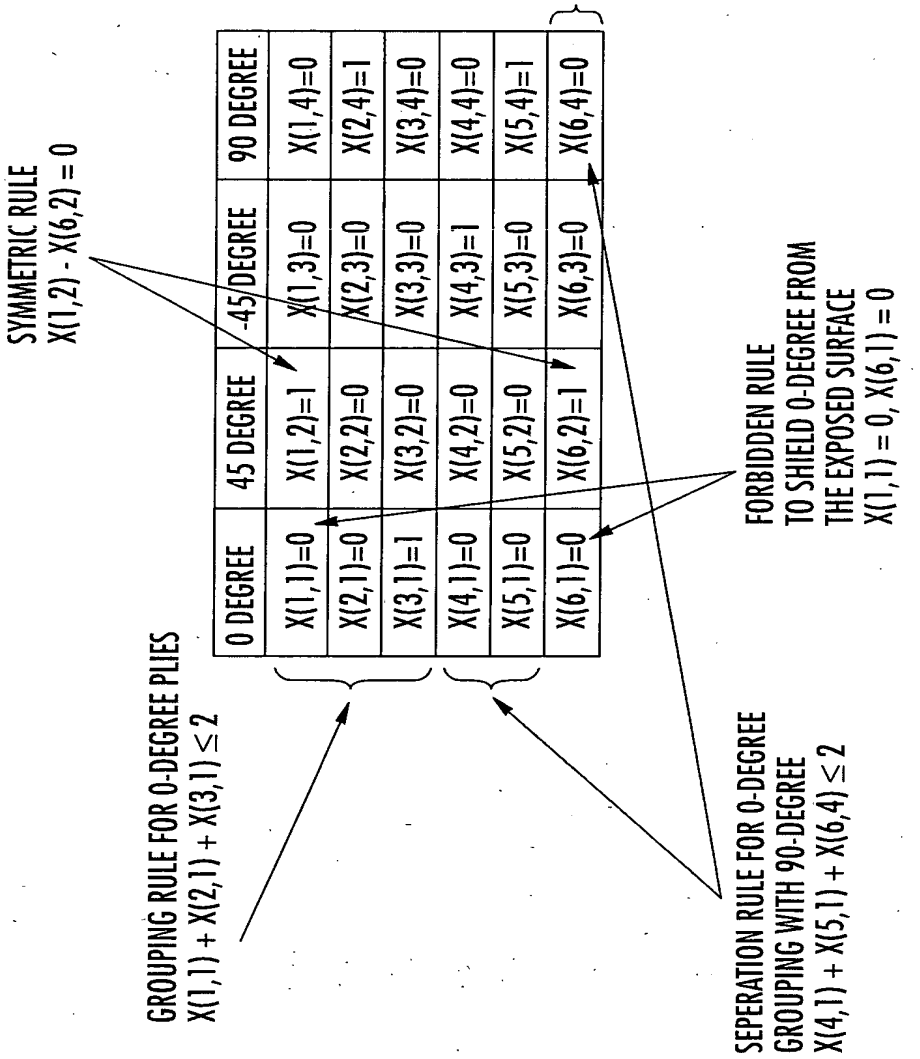

SYMMETRIC RULE
X(1,2) - X(6,2) = 0
0 DEGREE
45 DEGREE
-45/DEGREE
90 DEGREE
X(1,1)=0
X(1,2)=1
X(1,3)=0
X(1,4)=0
X(2,1)=0
X(2,2)=0
X(2,3)=0
X(2,4)=1
X(3,1)=1
X(3,2)=0
X(3,3)=0
X(3,4)=0
X(4,1)=0
X(4,2)=0
X(4,3)=1
X(4,4)=0
X(5,1)=0
X(5,2)=0
X(5,3)=0
X(5,4)=1
X(6,1)=0
X(6,2)=1
X(6,3)=0
X(6,4)=0
GROUPING RULE FOR 0-DEGREE PLIES
X(1,1) + X(2,1) + X(3,1) ≤ 2
FORBIDDEN RULE
TO SHIELD 0-DEGREE FROM
THE EXPOSED SURFACE
X(1,1) = 0, X(6,1) = 0
SEPERATION RULE FOR 0-DEGREE
GROUPING WITH 90-DEGREE
X(4,1) + X(5,1) + X(6,4) ≤ 2

FIG. 8

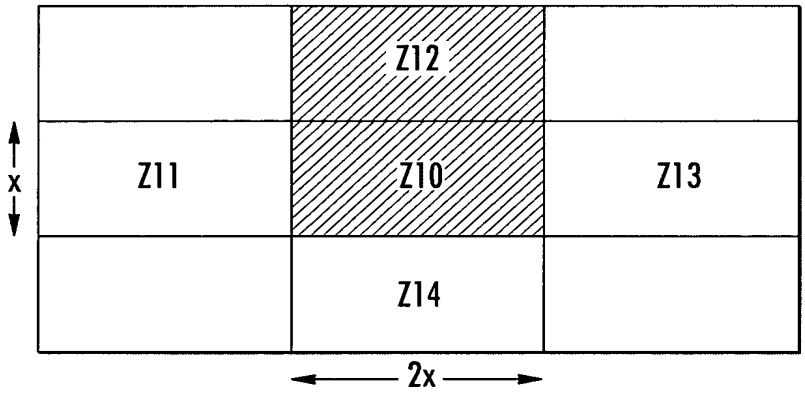


FIG. 9

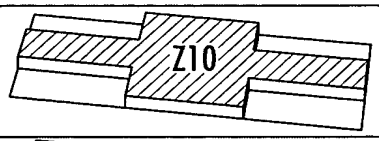
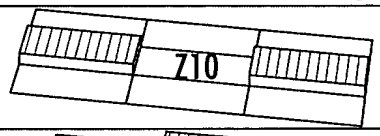
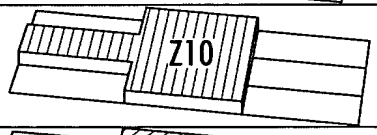
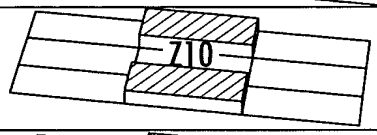
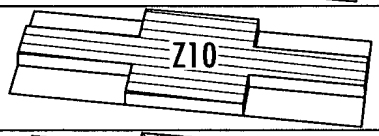
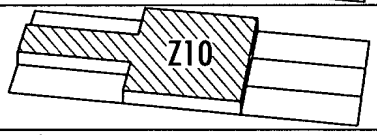
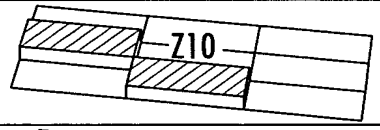
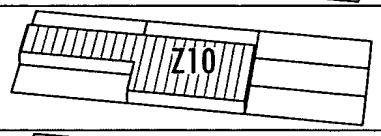
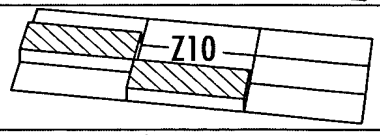
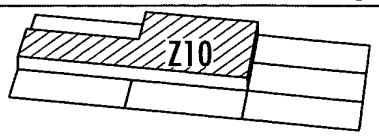
SEQ	MASTER	Z10	Z11	Z12	Z13	Z14	VOID EDGE	SOLID EDGE	VSD (J)	ILLUSTRATION OF SEQUENCE
1	45°	45°	45°	45°	45°	45°	0	6	-6	
2	90°	----	90°	----	90°	----	4	2	2	
3	90°	90°	90°	90°	----	90°	2	4	-2	
4	45°	----	----	45°	----	45°	2	4	-2	
5	0°	0°	0°	0°	0°	0°	0	6	-6	
6	-45°	-45°	-45°	-45°	----	-45°	1	5	-4	
7	45°	----	45°	----	----	45°	3	3	0	
8	90°	90°	90°	----	----	90°	3	3	0	
9	-45°	----	-45°	----	----	-45°	3	3	0	
10	45°	45°	45°	45°	----	----	3	3	0	

FIG. 10

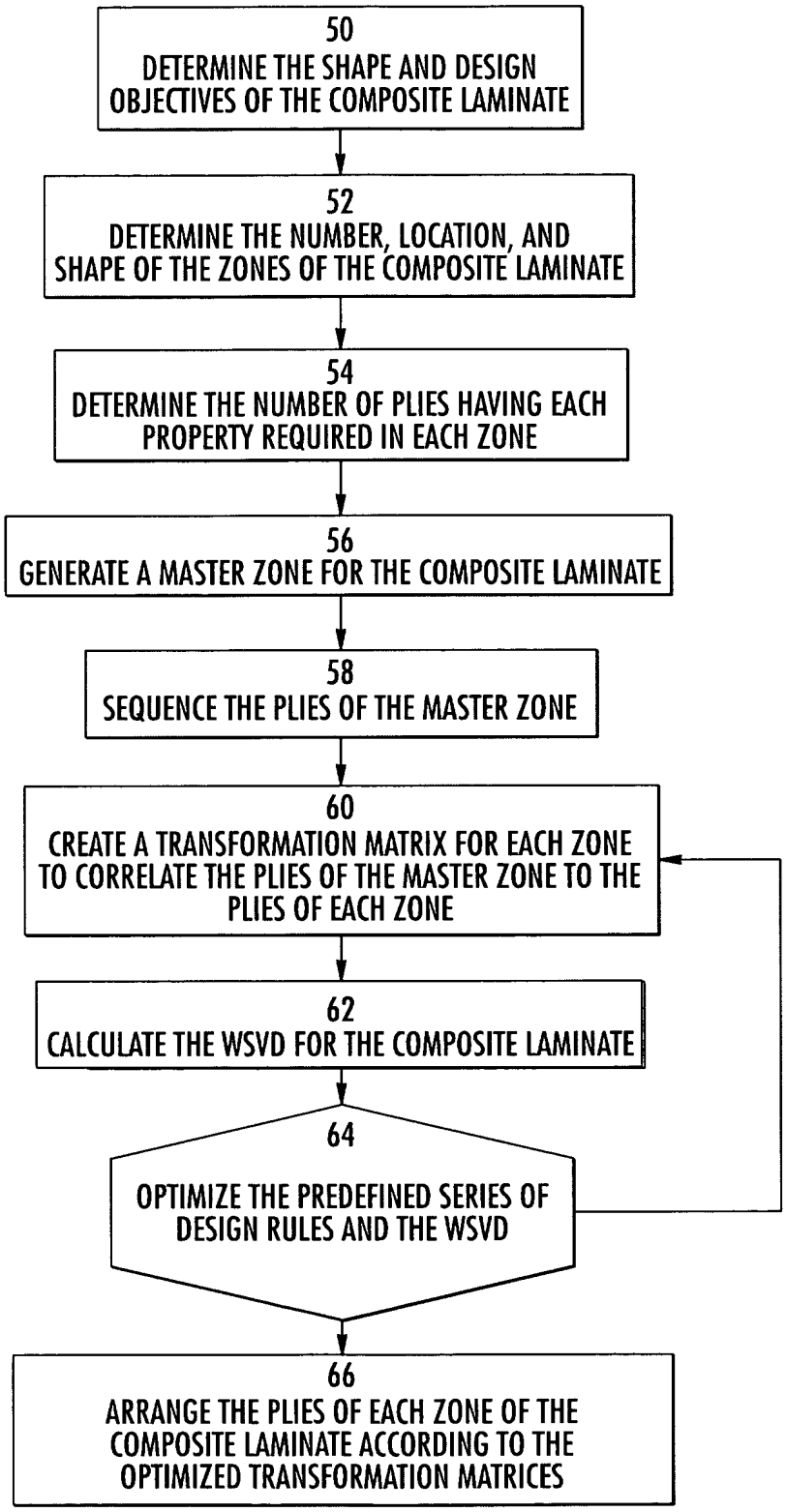

50
DETERMINE THE SHAPE AND DESIGN OBJECTIVES OF THE COMPOSITE LAMINATE
52
DETERMINE THE NUMBER, LOCATION, AND SHAPE OF THE ZONES OF THE COMPOSITE LAMINATE
54
DETERMINE THE NUMBER OF PLIES HAVING EACH PROPERTY REQUIRED IN EACH ZONE
56
GENERATE A MASTER ZONE FOR THE COMPOSITE LAMINATE
58
SEQUENCE THE PLIES OF THE MASTER ZONE
60
CREATE A TRANSFORMATION MATRIX FOR EACH ZONE TO CORRELATE THE PLIES OF THE MASTER ZONE TO THE PLIES OF EACH ZONE
62
CALCULATE THE WSVD FOR THE COMPOSITE LAMINATE
64
OPTIMIZE THE PREDEFINED SERIES OF DESIGN RULES AND THE WSVD
66
ARRANGE THE PLIES OF EACH ZONE OF THE COMPOSITE LAMINATE ACCORDING TO THE OPTIMIZED TRANSFORMATION MATRICES

FIG. 11